



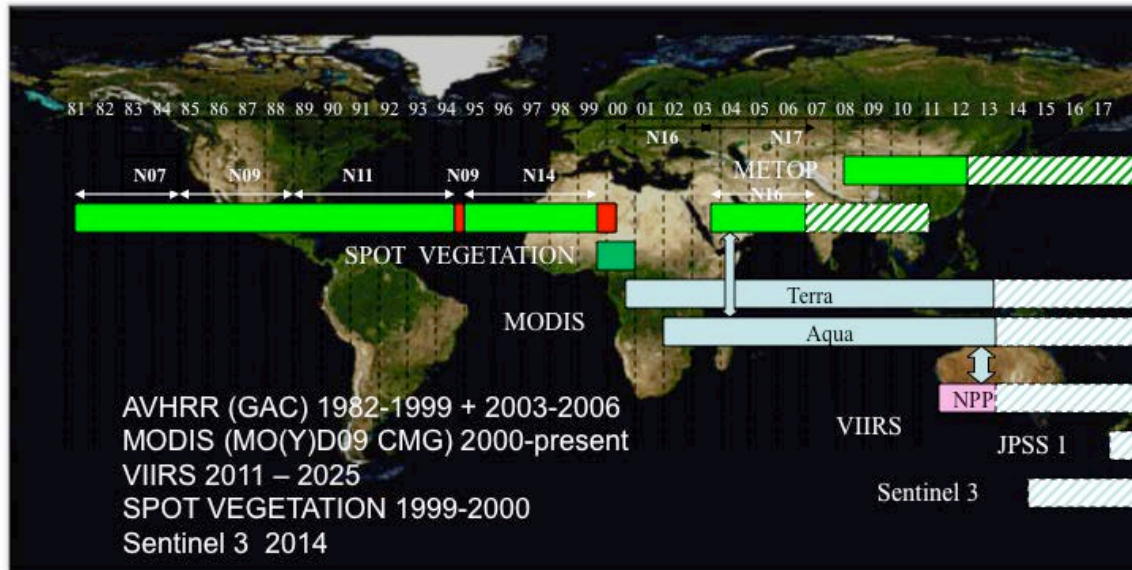
# **VIIRS Land Discipline Status**

## ***post-Terra/Aqua Senior Review and ROSES A.37***

Miguel Román (GSFC)  
with contributions from the  
T/A/S-NPP Land Discipline PIs and  
Land SIPS teams.



# Background



The Earth Observing System (represented by Terra/Aqua/Aura) was intended to provide global observations needed to advance Earth System Science and to initiate a number of improved long- term global data sets.

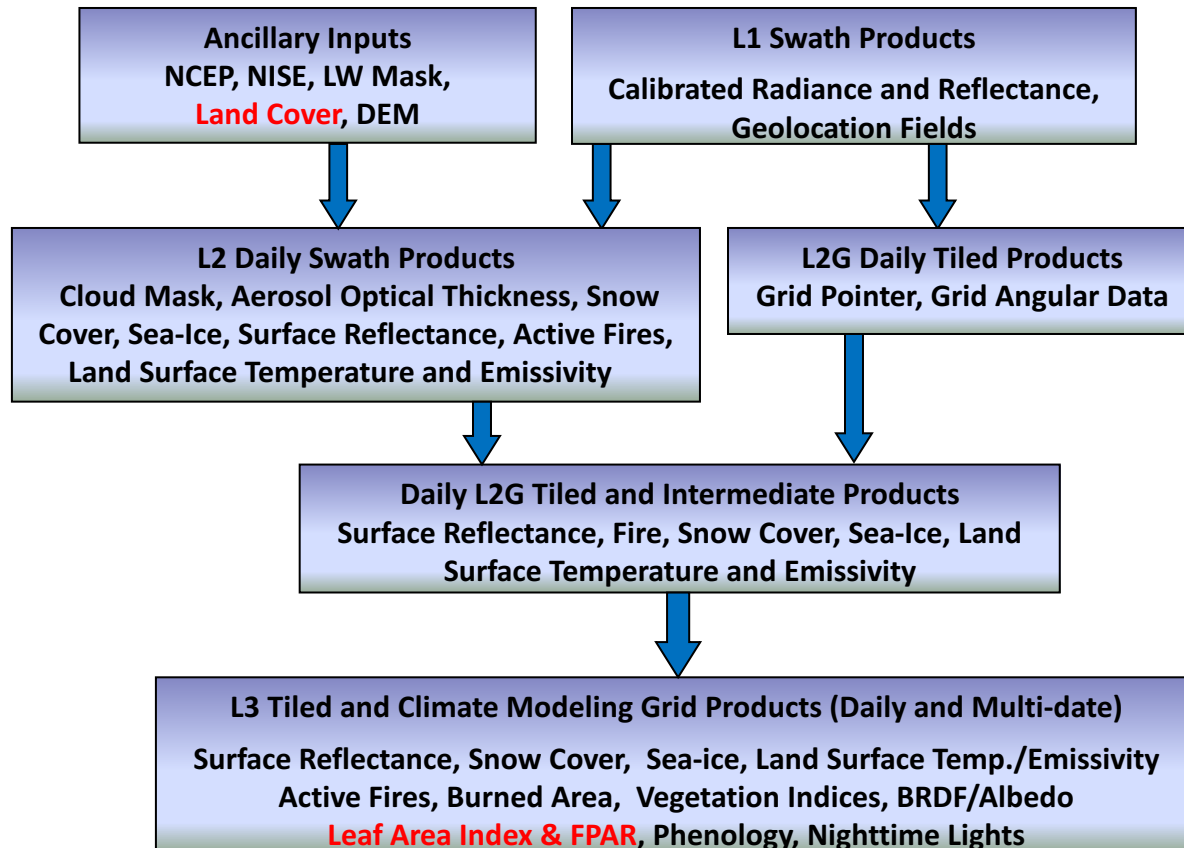
Suomi-NPP (launched in 2011) extends more than 11 high-quality Terrestrial Earth System Data Records (ESDRs) initiated by earlier NASA satellites.

## Products selected in 2017 ROSES TASNPP solicitation (A.37)

- Surface Reflectance and Vegetation Indices (**Vermote**)
  - Land Surface Temperature and Emissivity
  - Snow Cover, Sea Ice Cover and Ice Surface Temperature (**Riggs**)
  - Active Fires (**Schroeder and Giglio**)
  - Burned Area
  - Leaf Area Index (LAI) & Fraction Absorbed Photosynthetically Active Radiation (FPAR)
  - BRDF (Bi-directional Reflectance Distribution Function) / Albedo (**Schaaf**)
  - Vegetation Continuous Fields
  - Land Cover
  - VIIRS Land Surface Phenology (**Zhang**)
- New Standard/Experimental Products:**
- MODIS Radiation (**Wang**)
  - MAIAC (**Lyapustin**)
  - VIIRS Black Marble (**Román**)

## Orphaned Products

# NASA VIIRS Land Product Interdependencies



## Downstream Product Impacts

- Missing inputs to LAI product:
  - Level 3 Land Cover
- Missing inputs to Phenology Product:
  - Level 3 Land Cover
- Missing inputs to NASA Black Marble product (VNP46)
  - Level 3 Land Cover
  - Level 3 Leaf Area Index

*Through Terra/Aqua end of life, impacts on product interdependencies will continue to be mitigated using MODIS-equivalent C6 products.*

**A.37 Orphaned Products**

# V1.0 SNPP VIIRS Land Product Status

EOS Products	Algorithms Delivered to Land SIPS	Product Integration and Testing	ATBD Delivery	Delivery of User's Guide	Products Delivered to assigned DAAC
Surface Reflectance	✓	✓	✓	✓	✓
LAI/FPAR	✓	✓	✓	✓	✓
Snow Products	✓	✓	✓	✓	✓
MAIAC	Qtr 4, 2018	Qtr 4, 2018	Qtr 3, 2018	Qtr 1, 2019	V2.0 - Qtr 1, 2019
BRDF/Albedo	✓	✓	✓	✓	✓
Burned Area	Qtr 3, 2018	Qtr 4, 2018	✓	Qtr 4, 2018	Qtr 1, 2019
Active Fires	✓	✓	✓	✓	✓
Vegetation Index	✓	✓	✓	✓	✓
LST&E	✓	✓	✓	✓	Qtr 4, 2018
Ice Surface Temp	✓	✓	✓	✓	✓
Sea Ice Cover	✓	✓	✓	✓	✓
Phenology	✓	Underway	✓	✓	Qtr 4, 2018
Black Marble	✓	Underway	✓	✓	Qtr 1, 2019

**Details in Reports at the Land Break out session**

# **VIIRS Land SIPS Processing Status: V1.0 SNPP VIIRS**

- **V1 forward processing of Land products are typically 1-2 days behind real time.**
- **MODIS heritage VIIRS products generated using the NASA science team delivered algorithms.**
- **Uses V1 L1B SDR generated using the NOAA/IDPS Mx8.11 version of the operational software and NASA VCST provided LUT.**
- **L2 products are in HDF5/netcdf4 and L3/L4 products are in HDF5-EOS format.**
- **Products currently in operational processing and available to public from NASA DAACs**
  - **LSR, VI, BRDF-Albedo, LAI-Fpar, L2 Fire, L2 Snow and Sea-ice: Available for the mission period**
  - **L3 Fire, LST: Reprocessing in progress and to be completed in Nov 2018**
  - **BA, L3 Snow and Sea-ice, Phenology: Products to be available by Jan 2019**
- **NRT processing of V1 Land (using V1 L1B) is completed typically 2 to 2.5 hours after acquisition of data.**
  - **Products in processing – LSR, Fire, BRDF-Albedo, Snow and Sea-ice**

# **VIIRS Land SIPS Processing Plan: Beyond SNPP V1.0**

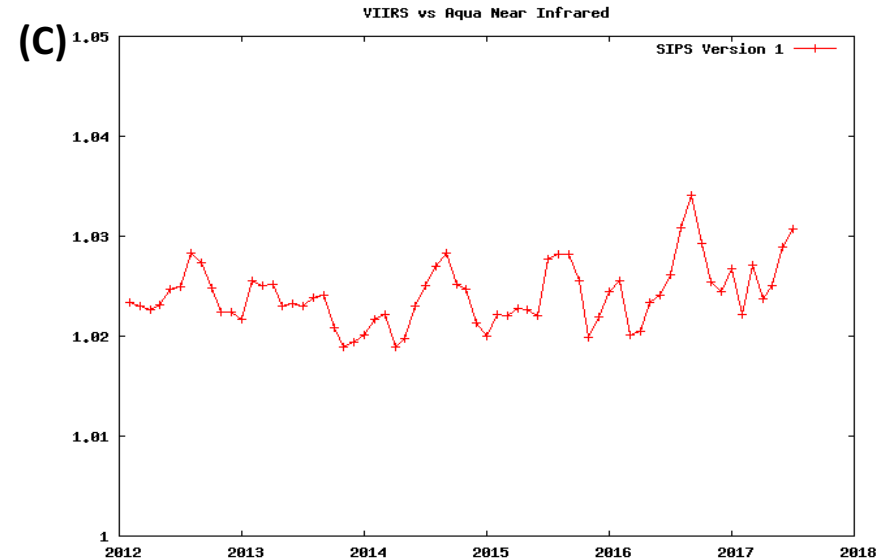
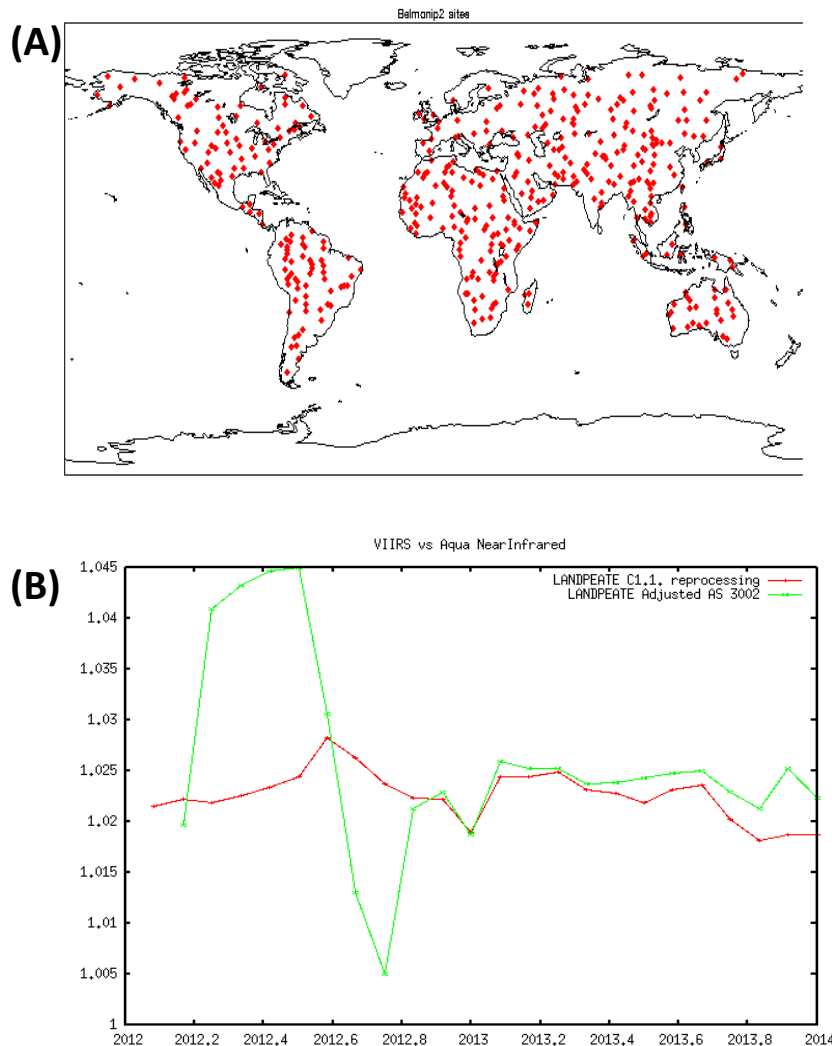
- **V2.0 SNPP VIIRS Land Reprocessing (Spring 2019)**
  - V2 Reprocessing will start after processing of proposed VIIRS land products is completed in the on-going V1 reprocessing.
  - This reprocessing will use the NASA L1B generated using the latest version of the L1B calibration algorithm and LUT delivered by the NASA VCST and Geo team.
  - Will use the Land PGEs used in the V1 reprocessing with NASA Science Team recommended changes.
- **V1.0/V2.0 J1 VIIRS Land Reprocessing (Spring 2019)**
  - Expected to start after completion of the SNPP V1 Land reprocessing.
  - Will use the SNPP VIIRS PGEs ported to process J1 VIIRS data
  - J1 VIIRS NASA L1B to be generated using the NASA calibration algorithm and post-launch calibration LUT delivered by the NASA VCST.

**Details in Reports at the Land Break out session**



# Generating consistent and continuous surface reflectance product suite from Suomi-NPP VIIRS and EOS MODIS

E. Vermote, S. Skakun, Roger JC, Franch B., J. Pinzón, C. Tucker



Cross comparison of the VIIRS and MODIS Aqua SR products for the BELMANIP2 sites (A). The plots show that the NASA reprocessing of VIIRS (C1.1) is in a good agreement with MODIS (B). Continuous monitoring of VIIRS Collection V1 reprocessing ensures product stability/consistency.

Key Findings: VIIRS SR product secures the Long Term data continuity from the MODIS global Land record which is crucial for the NASA Earth Science mission.





# Status of VIIRS SR



## VIIRS SR Product

### Collection 1: (Released in 2017)

- VNP09 (level 2 Surface Reflectance), VNP09G1KI, VNP09GHKI, and VNP09GA (gridded daily product at 500m and 1km), VNP09A1 and VNP09H1 (gridded 8 day composite product at 500m and 1km), VNP09CMG (the daily global product in the climate modeling grid at 0.05deg).

## Status and Updates:

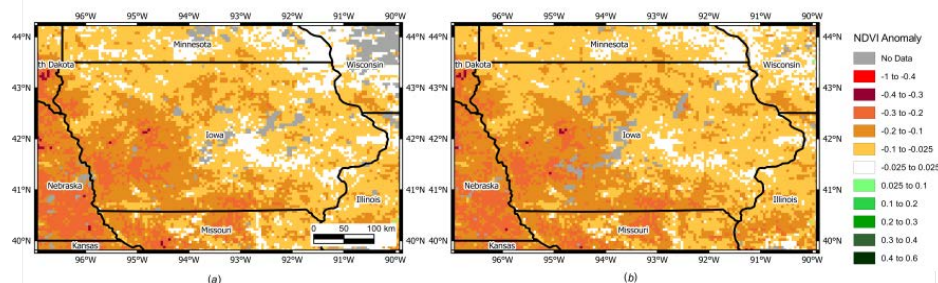
- Adapted from MODIS LaSRC (Land Surface Reflectance Code)
- Validation stage IV (AERONET) and cross-comparison with MODIS is on-going.

## Known Issues:

- None

## Recent Publications:

- Skakun, S., Justice, C.O., Vermote, E. and Roger, J.C., 2018. Transitioning from MODIS to VIIRS: an analysis of inter-consistency of NDVI data sets for agricultural monitoring. *International Journal of Remote Sensing*, 39(4), pp.971-992.
- Pahlevan, N., Sarkar, S., Devadiga, S., Wolfe, R.E., Román, M., Vermote, E., Lin, G., Xiong, X. (2016). Impact of Spatial Sampling on Continuity of MODIS-VIIRS Land Surface Reflectance Products: A Simulation Approach, *IEEE Transactions on Geoscience and Remote Sensing* 55.1 (2017): 183-196.
- Vermote E., Justice C., Csiszar I., Early evaluation of the VIIRS calibration, cloud mask and surface reflectance Earth data records, *Remote Sensing of Environment*, Volume 148, 25 May 2014, Pages 134-145, ISSN 0034-4257, <http://dx.doi.org/10.1016/j.rse.2014.03.028>



NDVI anomalies at 0.05° spatial resolution for the state of Iowa (US) derived from MODIS/Aqua (a), and adjusted VIIRS (b) data on August 21, 2012. Anomalies were computed by subtracting NDVI values from the median NDVI values for 2002–2016 derived from MODIS/Aqua

The derived uncertainties (for surface reflectance and VIs) related to the combined use of MODIS and VIIRS products are being estimated and reported to user community to further quantify uncertainties for high level products, (e.g. crop yield models).





# Status of VIIRS Burned Area



## VIIRS VNP64A1 Product

### Collection 1: (2019 release)

- VNP64A1: S-NPP Monthly L3 500 m SIN Grid
- VNP64CMH: Monthly CMG

## Status and Updates:

- Adapted from MODIS burned area science code.
- Upstream VNP64A0 intermediate product integrated into Land SIPS in September 2017.
- VNP64A1 code delivery awaiting sufficient upstream input data for testing and tuning.

VNP64A1 h17v08 2015 305-365 201302





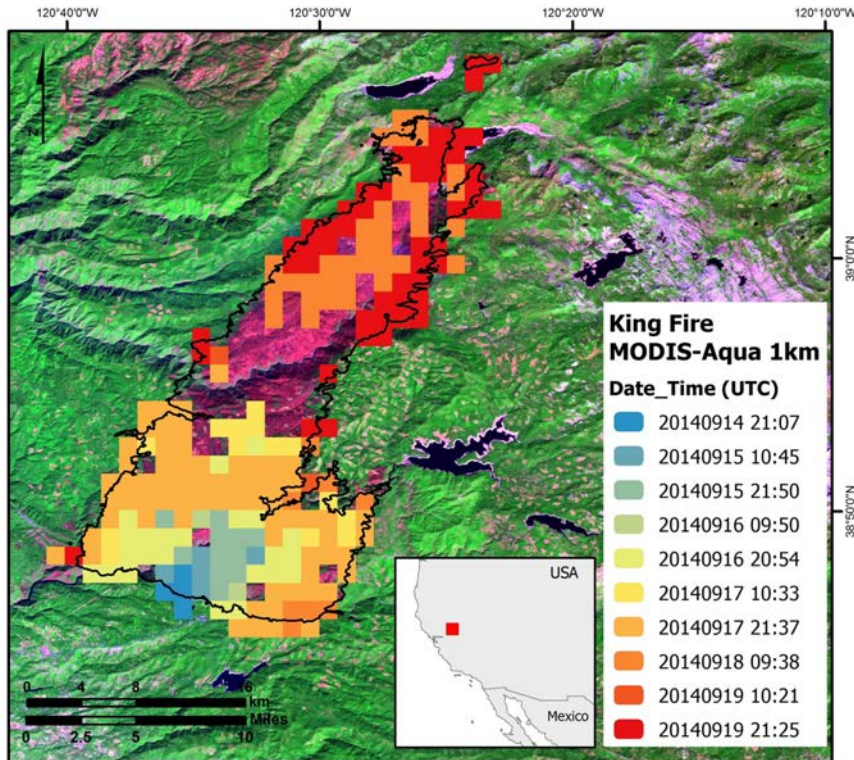
# S-NPP/VIIRS Active Fire Product Suite: Bridging EOS and JPSS



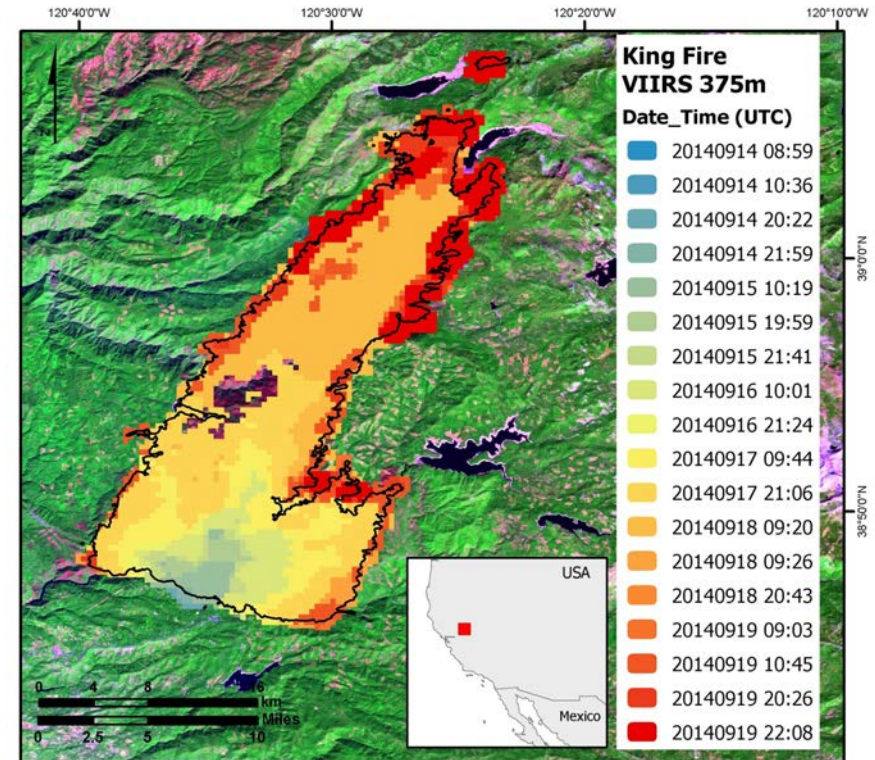
Louis Giglio<sup>1</sup>, Wilfrid Schroeder<sup>2</sup>, Joanne Hall<sup>1</sup>

<sup>1</sup>University of Maryland, <sup>2</sup>NOAA NESDIS

## Aqua/MODIS 1km



## S-NPP/VIIRS 375m



1-km Aqua MODIS (left) and near-coincident 375-m S-NPP VIIRS (right) mapping of fire progression during the 2014 King Fire event in California. Colored polygons describe the active fire pixel footprints of MODIS and VIIRS. The black polygon outlines the fire-affected area mapped using the background Landsat-8/OLI image acquired on 5 October 2014





# Status of VIIRS Active Fire



## VIIRS VNP14 Product Family

### Collection 1: (2017 release)

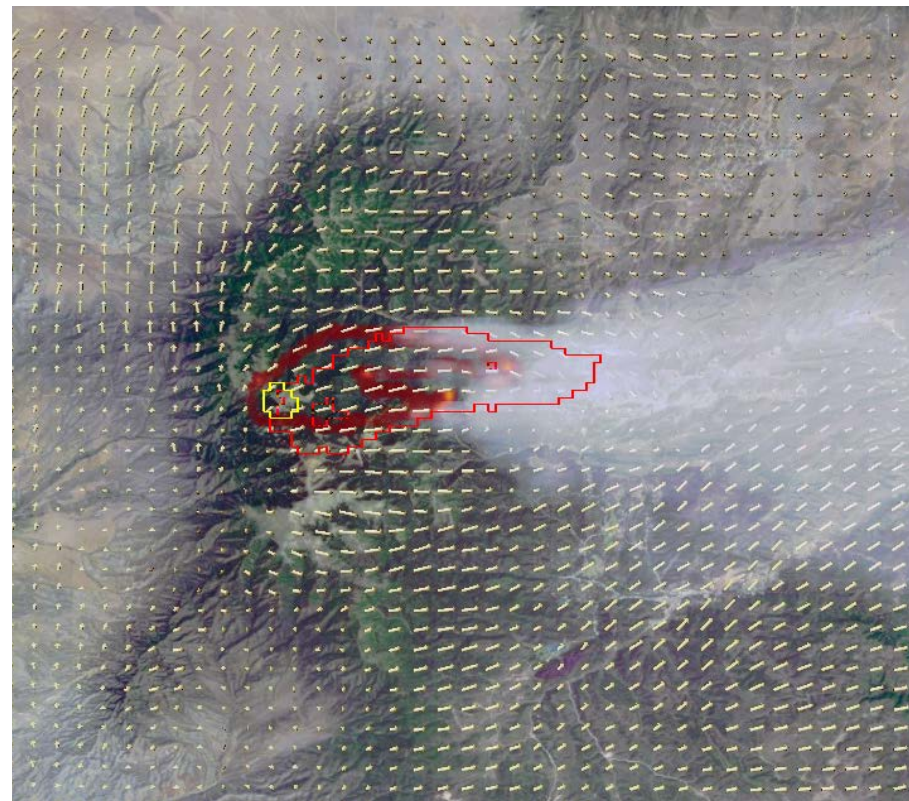
- VNP14: L2 750-m
- VNP14IMG: L2 375-m
- VNP14A1: Daily L3 1 km SIN Grid

## Status and Updates:

- Adapted from MODIS active fire detection algorithm.
- 375-m product much more sensitive to small fires.
- NRT version of 375-m product produced in LANCE and distributed by FIRMS.

## Known Issues:

- M13 atmospheric absorption
- Proper flagging of uncalibrated and/or poorly calibrated radiance data



**Yellow perimeter:** VIIRS fire perimeter used for model initialization. **Red perimeter:** VIIRS fire perimeter 12 h later.

VIIRS 375-m fire product now allows robust predictive fire modeling to be performed in NRT using CAWFE model (J. Coen, NCAR).

# Consistent BRDF, Albedo, and NBAR products from Suomi-NPP VIIRS and Terra/Aqua MODIS

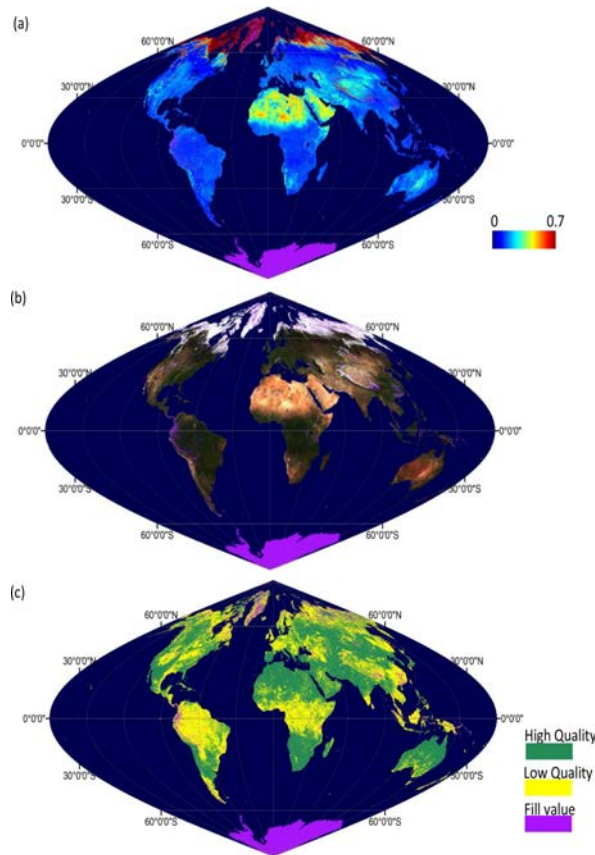
Crystal Schaaf<sup>1</sup>, Zhuosen Wang<sup>2,3</sup>, Qingsong Sun<sup>2,4</sup>, Yan Liu<sup>1</sup>, Zhan Li<sup>1</sup>,  
Angela Erb<sup>1</sup>, Arthur Elmes<sup>1</sup>, Jia Tian<sup>1</sup>

<sup>1</sup> School for the Environment, University of Massachusetts Boston, Boston MA, USA

<sup>2</sup> Terrestrial Information Systems Lab, NASA Goddard Space Flight Center, Greenbelt, MD, USA

<sup>3</sup> Earth System Science Interdisciplinary Center, University of Maryland, College Park, MD, USA

<sup>4</sup> Science Systems and Applications, Inc., Lanham, MD, USA



The MODIS and VIIRS products rely on high quality multi-date, multi-angle surface reflectances to retrieve a daily surface BRDF for each gridpoint. This BRDF is then used to produce **White Sky Albedo** (bihemispherical albedo under isotropic illumination), **Black Sky Albedo** (directional hemispherical albedo under local solar noon illumination) and Nadir BRDF-Adjusted Reflectance (NBAR). Extensive QA fields are provided. Albedo is retrieved as either a snow albedo or a snow free albedo depending on the condition of the daily day of interest.

VIIRS BRDF, Albedo and NBAR are providing products consistent with the corresponding MODIS products. New narrow to broadband conversion coefficients have been developed to produce the broadband values most commonly measured by field instruments and used in modeling studies.

Figure (a) VIIRS shortwave broadband WSA, 9 May 2015, (b) True color NBAR M5-Red, M4-Green, and M3-Blue: 0-0.4, (c) QA

# Status of Suomi-NPP VIIRS BRDF, Albedo and NBAR

## VIIRS BRDF, Albedo, NBAR Product

Collection V001: (Released in 2018)

- VNP43A: VIIRS/S-NPP Daily L4 500 m SIN Grid –
- VNP43IA1/VNP43MA1: BRDF/Albedo Model Parameters for Imagery (IA) and Moderate (MA) bands
- VNP43IA2/VNP43MA2: BRDF/Albedo Quality
- VNP43IA3/VNP43MA3: Albedo
- VNP43IA4/VNP43MA4: NBAR
- VNP43DNBA1: DNB BRDF/Albedo Model Parameters
- VNP43DNBA2: DNB BRDF/Albedo Quality
- VNP43DNBA3: DNB Albedo
- VNP43DNBA4: DNB NBAR

## Status and Updates:

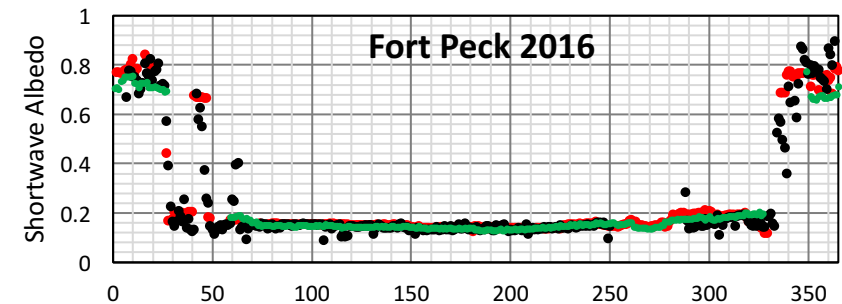
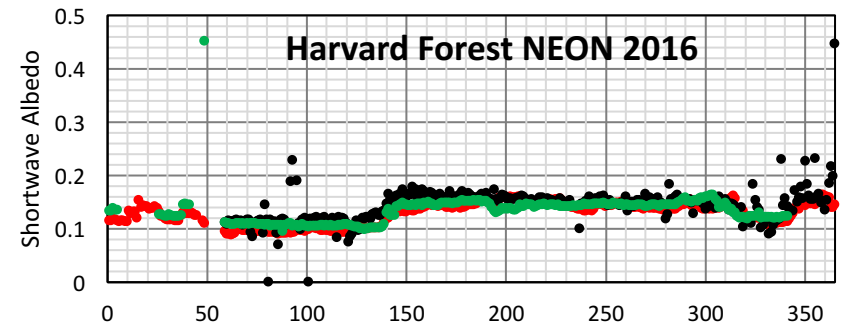
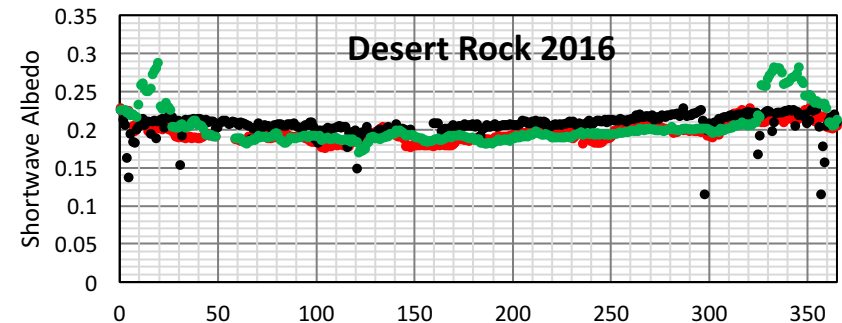
- CMG products are integrated and being tested and reviewed.
- Albedo product compared to tower albedos, e.g. from SURFRAD: Desert Rock and Fort Peck, and NEON: Harvard Forest

## Known Issues:

- None

## Recent Publications:

- Liu, Y., Wang, Z., Sun, Q., Erb, A. M., Li, Z., Schaaf, C. B., Zhang, X., Román, M. O., Scott, R. L., Zhang, Q., Novick, K. A., Syndonia Bret-Harte, M., Petroy, S., & SanClements, M. (2017). Evaluation of the VIIRS BRDF, Albedo and NBAR products suite and an assessment of continuity with the long term MODIS record. *Remote Sensing of Environment*, 201(Febuary), 256–274. <https://doi.org/10.1016/j.rse.2017.09.020>
- Liu, Y., Hill, M. J., Zhang, X., Wang, Z., Richardson, A. D., Hufkens, K., Filippa, G., Baldocchi, D. D., Ma, S., Verfaillie, J., & Schaaf, C. B. (2017). Using data from Landsat, MODIS, VIIRS and PhenoCams to monitor the phenology of California oak/grass savanna and open grassland across spatial scales. *Agricultural and Forest Meteorology*, 237–238, 311–325. <https://doi.org/10.1016/j.agrformet.2017.02.026>



● VIIRS Albedo ● Surface Albedo ● MODIS Albedo





# Status of VIIRS Cryosphere Products

George Riggs<sup>1</sup>, Dorothy Hall<sup>2</sup> and Mark Tschudi<sup>3</sup>

<sup>1</sup>SSAI, <sup>2</sup>ESSIC / University of Maryland, <sup>3</sup>University of Colorado, Boulder



## VIIRS Products:

### L2

- Snow Cover
- Sea Ice Extent
- Sea Ice Surface Temperature (IST)

### L3

- Snow Cover

## Status and Updates:

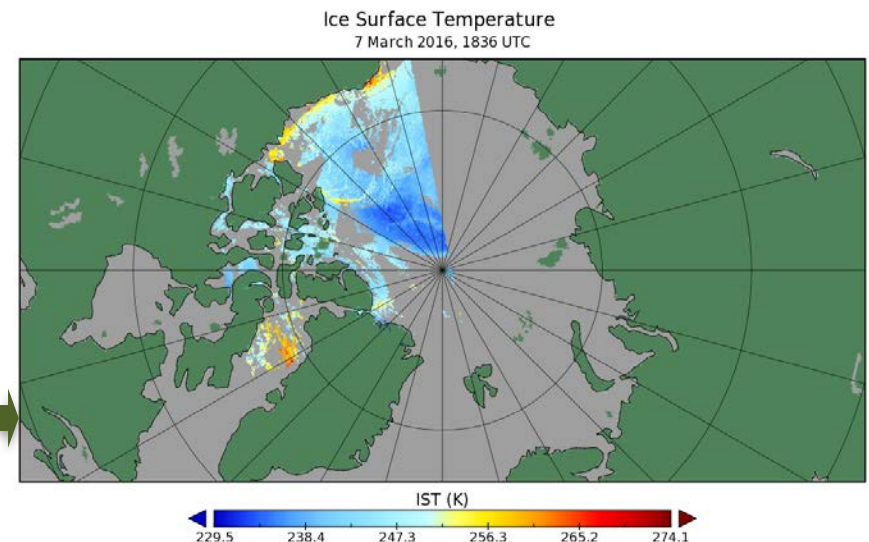
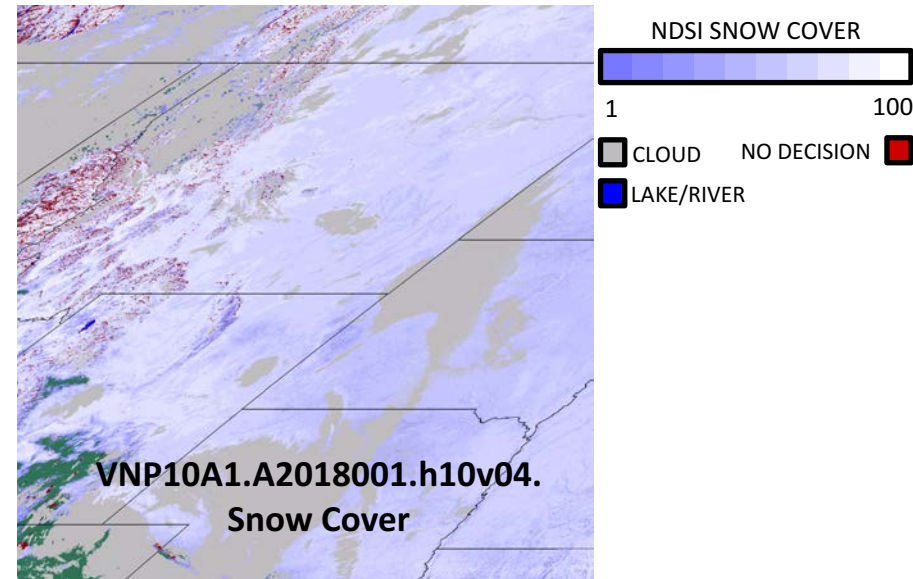
- L3 snow cover code delivered, in test
- VIIRS cloud-gap-filled snow cover product, similar to MODIS, will be developed
- Revised codes to use NASA VNP L1B input products
- Investigating cloud/snow confusion and aerosol effects
- IST validated
- Products user guide is being updated

## Known Issues:

- Change to using the University of Wisconsin VIIRS cloud mask product as input.
- Collection 2 – evaluate change to using NASA VNP L1B inputs in the L2 algorithms.

## Recent Publications:

*VIIRS IST product is a potential contribution to performance element 3.1.4 of the Arctic research plan of the Interagency Arctic Research Policy Committee (IARPC).*





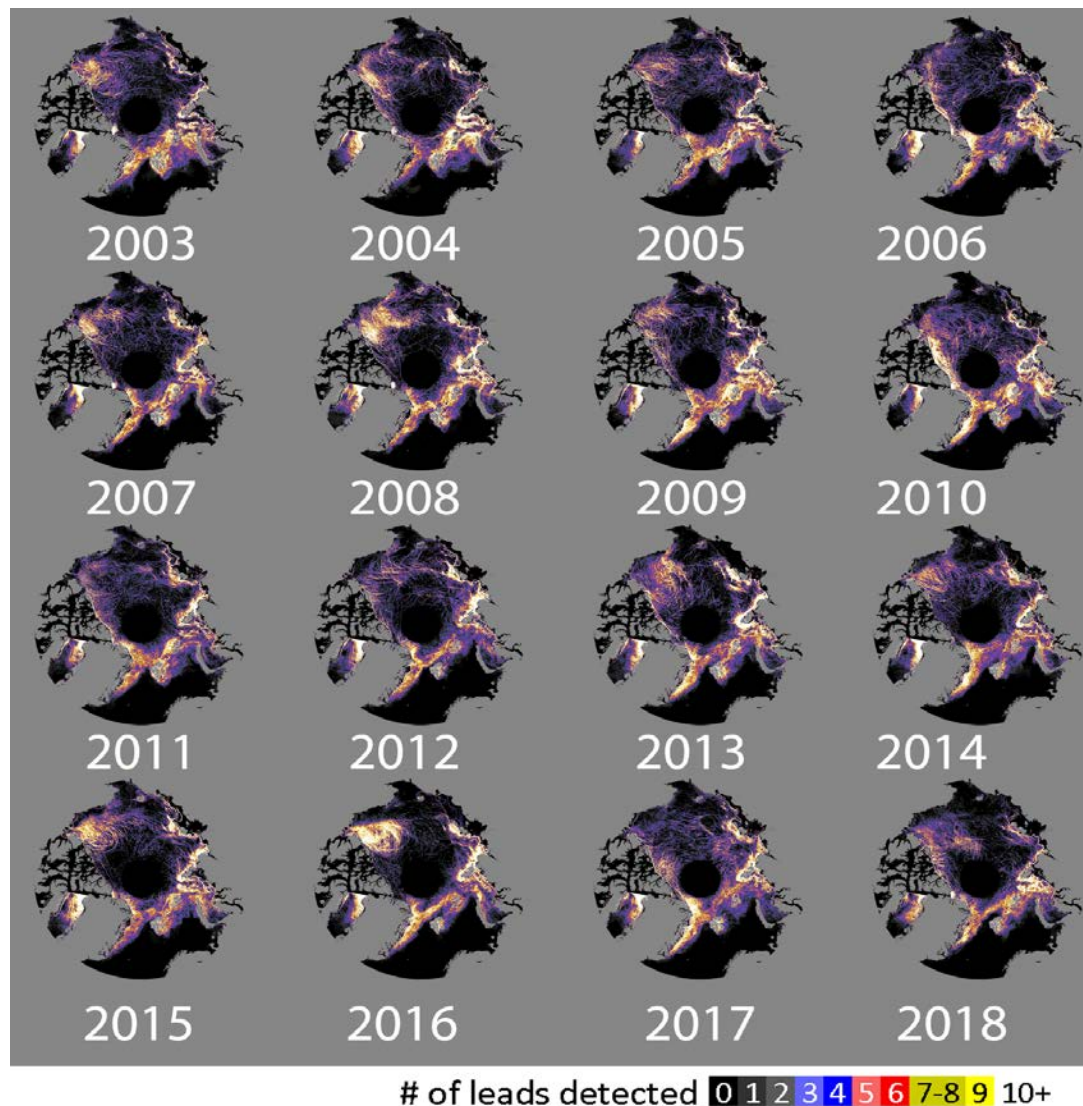
# Arctic Sea Ice Lead Properties from MODIS/VIIRS



Sea ice leads play a critical role in the exchange of mass and energy between the ocean and atmosphere in the polar regions, particularly in the Arctic. We are developing a methodology to detect and characterize sea ice leads applied to MODIS and VIIRS data to identify lead characteristics, including width, orientation, and spatial distribution, which can aid in navigation and is essential to investigate any correlations with observed changes in the Arctic Sea Ice.

Leads frequency map by year. Legend is at bottom of the figure.

Season is January - April







# Status of VIIRS MAIAC



## VIIRS MAIAC Product

- N/A

## Status and Updates:

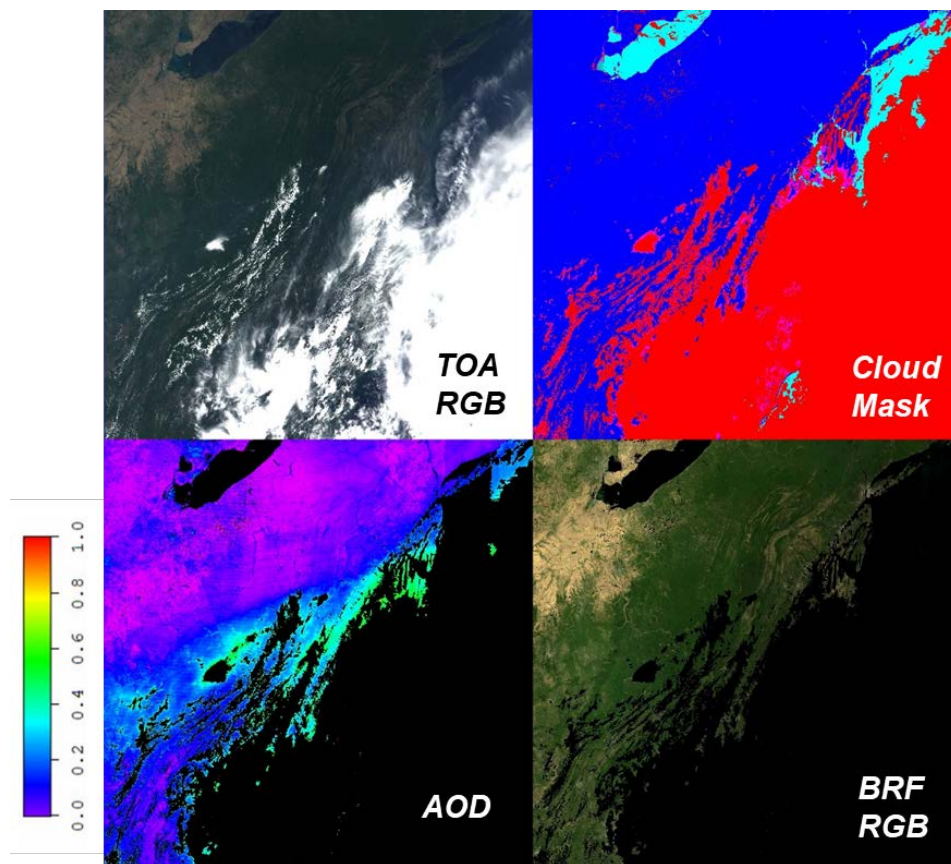
- Adapted from MODIS MAIAC C6.1 operational code.
- The input area-weighted gridding algorithm has just been delivered (V. Kalb, R. Wolfe).
- Delivery of tested VIIRS code expected late 2018.

## Known Issues:

- N/A

## Recent Publications:

- N/A



Example of MAIAC processing of the VIIRS measurements over the East Coast USA for 17 May, 2012 illustrating MAIAC cloud mask (CM), aerosol optical depth (AOD) at  $0.44\mu\text{m}$ , and RGB result of atmospheric correction.



# Status of VIIRS LAI/FPAR



## VIIRS LAI/FPAR Product

### Collection 1: (Released in 2018)

- VNP15A2H: VIIRS/S-NPP 8-Day L4 500 m SIN Grid

## Status and Updates:

- Adapted from MODIS LAI/FPAR science code.
- Results are reviewed and validated.

## Known Issues:

- Product has been orphaned post-A.37.

## Recent Publications:

- Xu et al., 2018. Analysis of Global LAI/FPAR Products from VIIRS and MODIS Sensors for Spatio-Temporal Consistency and Uncertainty from 2012–2016. **Forests**, doi:10.3390/f9020073
- Yan et al., 2017. Generating Global Products of LAI and FPAR From SNPP-VIIRS Data: Theoretical Background and Implementation. **IEEE TGRSS.**, doi:10.1109/TGRS.2017.2775247

 **NASAEarthdata**   
@NASAEarthData

Following

New S-NPP #NASA VIIRS Leaf Area Index/FPAR Data Product released at NASA's Land Processes DAAC! This #data set provides information about canopy leaf cover + the amount of solar energy absorbed through photosynthesis. #remotesensing #VIIRS #LAI #FPAR, [bit.ly/2JgJUBF](https://bit.ly/2JgJUBF)



May 25 - Jun 1, 2018

2:40 PM - 6 Jun 2018

7 Retweets 7 Likes



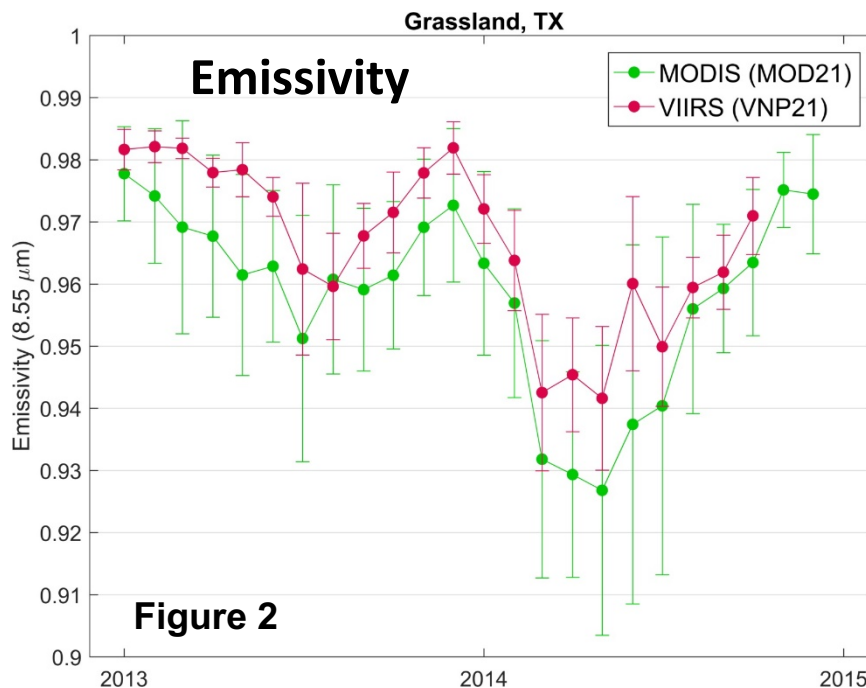
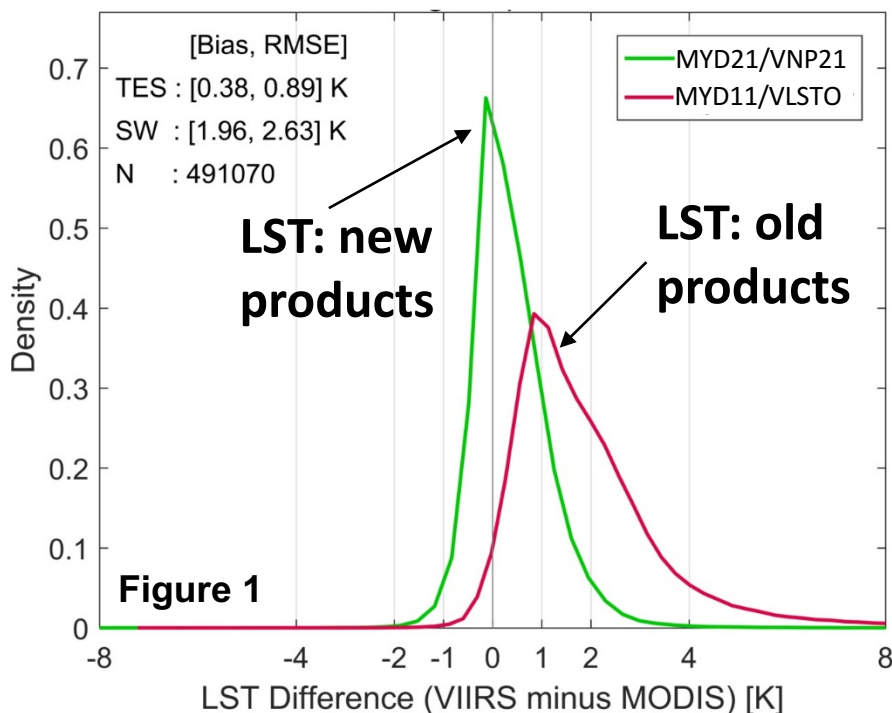
Ecological Society

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# MODIS/VIIRS LST&E Continuity

2013-2015 VIIRS/MODIS Matchups, CONUS



- Land Surface Temperature and Emissivity (LST&E) are key variables used in a wide range of studies including climate variability, land cover use/change, and the energy balance between land and atmosphere.
- New NASA LST&E products for MODIS (MxD21) and VIIRS (VNP21) being produced in 2017 use a consistent algorithm (TES) that physically retrieves both LST and emissivity and addresses discrepancies between the current suite of MODIS and VIIRS LST split-window based products (MYD11, VLSTO).
- Continuity between the new MYD21/VNP21 LST data records was demonstrated at the  $<\pm 1$  K level (**Figure 1**) that are invariant on atmospheric conditions and land cover type (Hulley et al. 2017). Retrieved emissivities at 8.55 micron also showed close agreement in both emissivity magnitude and temporal variation (**Figure 2**).



# Status of VIIRS LST&E



## Status and Updates:

- New LST&E product in VIIRS Collection 1
- Final science test complete and evaluation at LDOPE. Reprocessing to begin in Fall 2018

## VNP21 LST&E Products:

### Collection 1: (Release Fall 2018)

- VNP21 L2: Daily 5-min L2 Swath 750m
- VNP21A1: Daily L3 Global 750m
- VNP21A2 8-day L3 Global 750m

### Products still in development:

- VNP21C1: Daily 0.05 degree Climate Modeling Grid (CMG)
- VNP21C2: 8-day 0.05 degree Climate Modeling Grid (CMG)
- VNP21C3: Monthly 0.05 degree Climate Modeling Grid (CMG)

## Known Issues:

- Limited support through next funding cycle resulting in semi-orphaned products and limited support for validation and uncertainty quantification.

## Publications/Documentation:

- *Hulley, G. C., Malakar, N., Islam, T., Freepartner, R, (2017), NASA's MODIS and VIIRS Land Surface Temperature and Emissivity Products: A Consistent and High Quality Earth System Data Record, IEEE TGRS, DOI: 10.1109/JSTARS.2017.2779330.*
- *Islam, T., G. C. Hulley, N. Malakar, R. Radocinski, S. Hook, P. Guillevic (2016), A physics-based algorithm for the simultaneous retrieval of land surface temperature and emissivity from VIIRS thermal infrared data, IEEE Transactions on Geoscience and Remote Sensing, 55, 563-576*
- *User guide and ATBD available at: [https://lpvs.gsfc.nasa.gov/LSTE/LSTE\\_home.html](https://lpvs.gsfc.nasa.gov/LSTE/LSTE_home.html)*





# Status of VIIRS VI Time Series

## VIIRS VI Product Collection 1

### Collection 1: (Released in 2018)

- Consistent with MODIS product suite (16-day and monthly 500 m, 1 km, and CMG)

## Status and Updates:

- Solid QA-driven compositing approach adopted from the MODIS C5 Science Algorithm and based on daily inputs
- The full VIIRS time series is regularly compared to MODIS Aqua (Terra)
- Time series fully characterized with explicit MODIS T/A continuity transfer functions

## Known Issues:

- Algorithm/Product suite orphaned and no longer supported/funded (post A.37) while the PI/SCF continues to support the Algorithm & time series due to its critical value to the science community (there are thousands of users and tens of global agencies and private companies that depend on our effort and continued support).

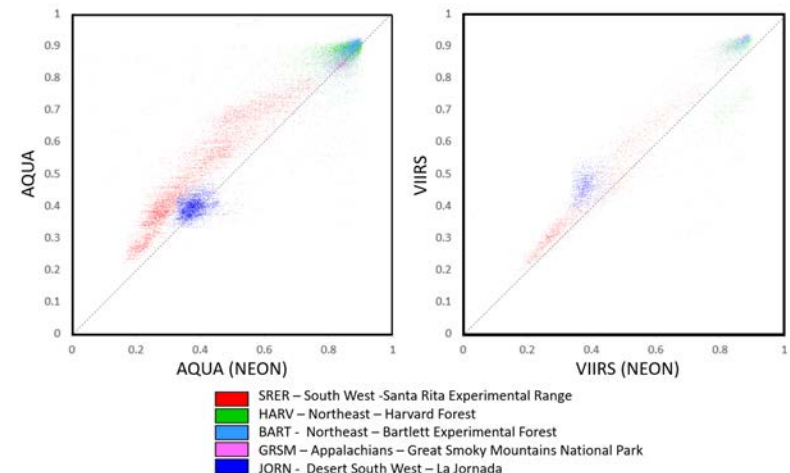
## Recent Publications:

- Jarchow, C. J., Didan, K., Barreto-Muñoz, A., Nagler, P. L., & Glenn, E. P. (2018). Application and Comparison of the MODIS-Derived Enhanced Vegetation Index to VIIRS, Landsat 5 TM and Landsat 8 OLI Platforms: A Case Study in the Arid Colorado River Delta, Mexico. *Sensors*, 18(5), 1546.
- EL-Vilaly, M. A. S., Didan, K., Marsh, S. E., Crimmins, M. A., & Munoz, A. B. (2018). Characterizing Drought Effects on Vegetation Productivity in the Four Corners Region of the US Southwest. *Sustainability*, 10(5), 1643.

## VIIRS VI Product Suite just released



## Aqua and S-NPP VIIRS NDVI/EVI Time Series Opportunistic Validation with NEON Data. Strong VIIRS Performance



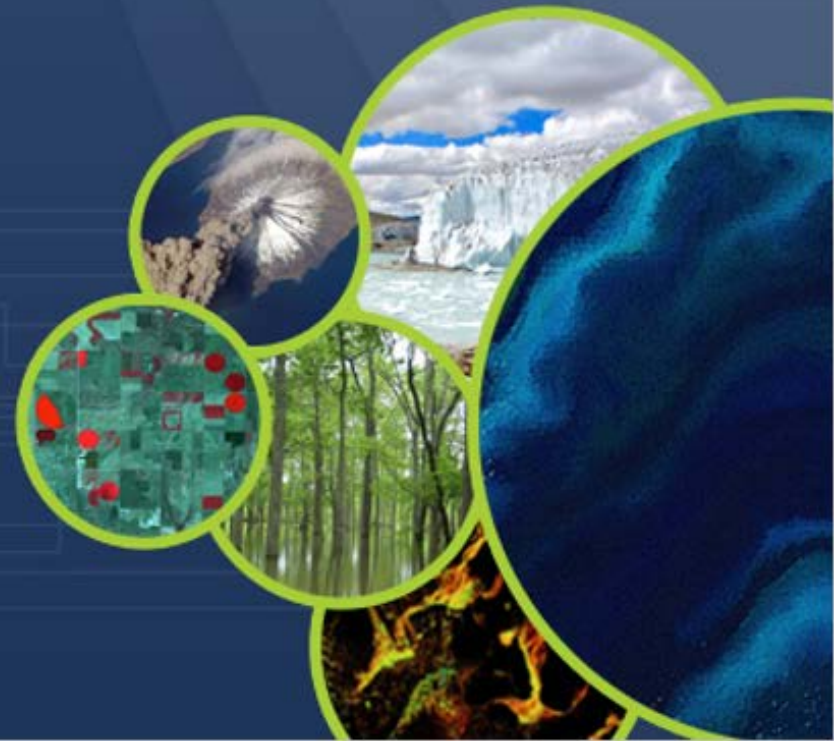
# Validation Efforts..



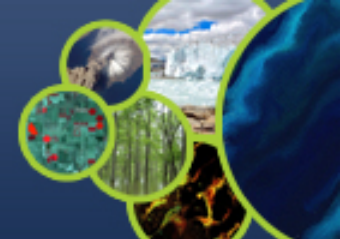
Committee on Earth Observation Satellites

# Working Group on Calibration and Validation Land Product Validation (LPV)

**Miguel Román (NASA Goddard)**  
**Jaime Nickeson (NASA Goddard)**  
**Laura Duncanson (Univ. Maryland)**  
**Zhuosen Wang (Univ. Maryland)**



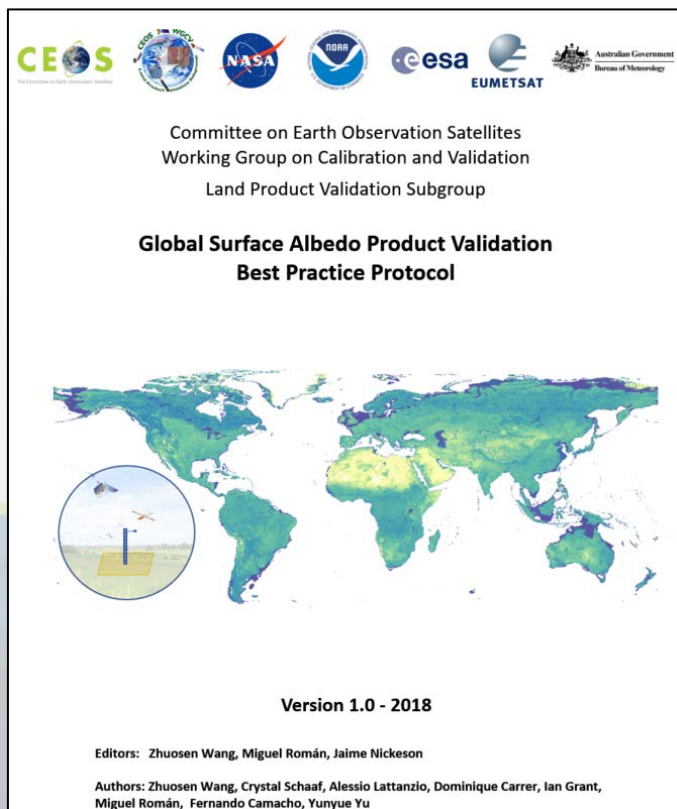
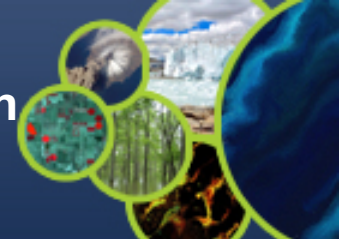




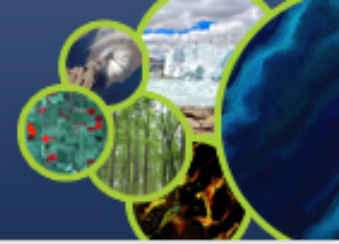
## 3.2 Progress on the implementation of the CEOS Strategy for Carbon Observations from Space

CARB-19: Land product validation listing and framework	Q4 2017	<p>Summarize current list of validated land data products relevant to Carbon Strategy.</p> <p><b>Document validation framework and protocols</b></p> <p><b>Provide guidance for online platform for intercomparison of terrestrial carbon products.</b></p>	WGCV
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Action Completed at WGCV-43



**Authors: Z. Wang, C. Schaaf, A. Lattanzio, D. Carrer, I. Grant, M. Román, F. Camacho, Y. Yu.**



## CEOS-LPV Super Site page added to LPV web site:

- **Definition:** Well-characterized (canopy structure and biogeophysical variables) site following well-established protocols useful for the validation of satellite land products and for radiative transfer modeling approaches. Active long term operations (funding and infrastructure support).
  - **Interactive map** of sites, color coded by network (10 networks included). Click on site renders a pop-up window with site name, land cover type, and a link to site network page.
- Page includes a link to spreadsheet of **site details**.
- Link to selection **report**: <https://goo.gl/Mw7RMz>).
- **Objective site selection process** helps inform CEOS Agency field experiments (e.g., ESAFiducial Reference Measurement framework: <https://earth.esa.int/web/sppa/activities/frm>).

**CEOS Working Group on Calibration and Validation**

**Land Product Validation Subgroup**

HOME ABOUT DOCUMENTS PEOPLE LINKS

**LPV Supersites**

**CEOS land validation sites**

The CEOS Land Product Validation subgroup adopted the EOS Land Validation core sites back in the early MODIS era, and augmented the list with more European and international coverage in the mid 2000s. But many of these sites were not longer active, and our needs and strategy for ground reference sites have changed over time. The LPV thus undertook an effort to define and evaluate several study sites that could fulfill the needs of multiple products within our focus areas.

We have defined sites that we refer to as LPV Supersites as:

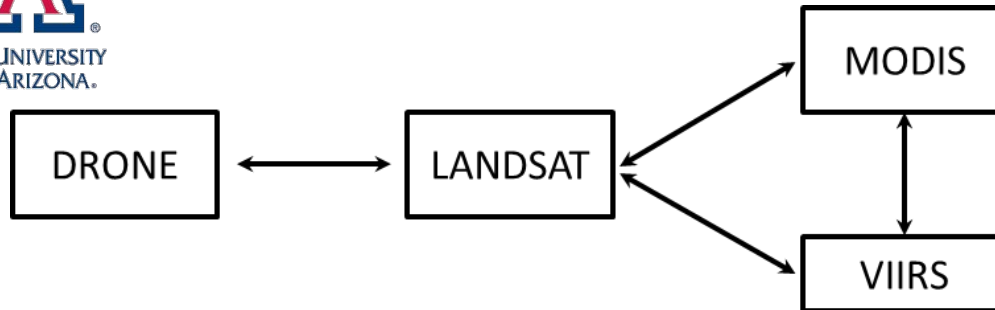
- Super characterized (canopy structure and biogeophysical variables) site following well-established protocols useful for the validation of satellite land products (at least 3) and for radiative transfer modeling approaches.
- Active, long-term operations, supported by appropriate funding and infrastructure capacity.
- Supported by airborne LiDAR and hyperspectral acquisitions (desirable).

The supersites were selected primarily from well known and established networks, and several were also nominated by each of the LPV focus areas, and then all sites were evaluated for their suitability by ranking them first based on the availability of data (active site) and their spatial representativeness. After this, the variables were ranked based on how many key variables could be validated with a given site, whether structural, informal atmospheric and other properties were measured. The sites were also ranked according to global region and by land cover type. To come up with a score for each site and a cut-off was established for accepting a given site. The subset of sites that we are shown on the map below, and in this [spreadsheet](#).

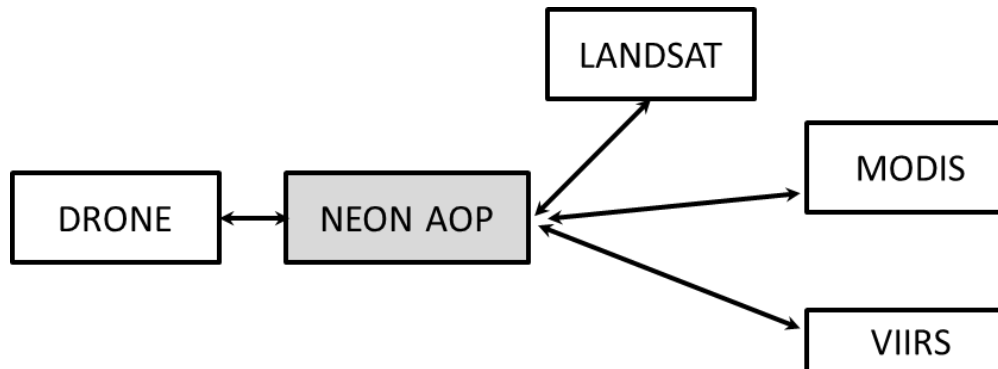
Colletongo  
Tree Cover, broadleaved, deciduous, closed

Network Visibility: TERN NEON ENV EFDC NCC ForestGeo ICOS KIT LTER

# Cross sensors validation



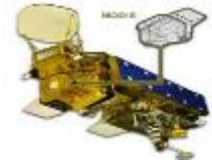
a) Direct sensor validation



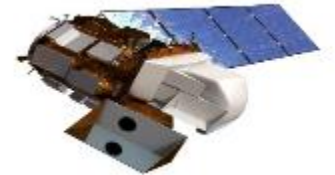
b) Calibration using NEON simulated datasets



VIIRS



MODIS



Landsat 8



NEON AOP



VIPLab Drone



# Convolution



NEON Convolution - Mozilla Firefox

https://vip.arizona.edu/vipweb/webgui/NE

NEON Convolution

Extent (lat/lon dec)

Get North 31.86531205147627 West -110.9076690673828  
South 31.8183555458965 East -110.8493041992187

Sensor LANDSAT8/OLI Spectral + spatial

Output format HDF4

Wait processing...

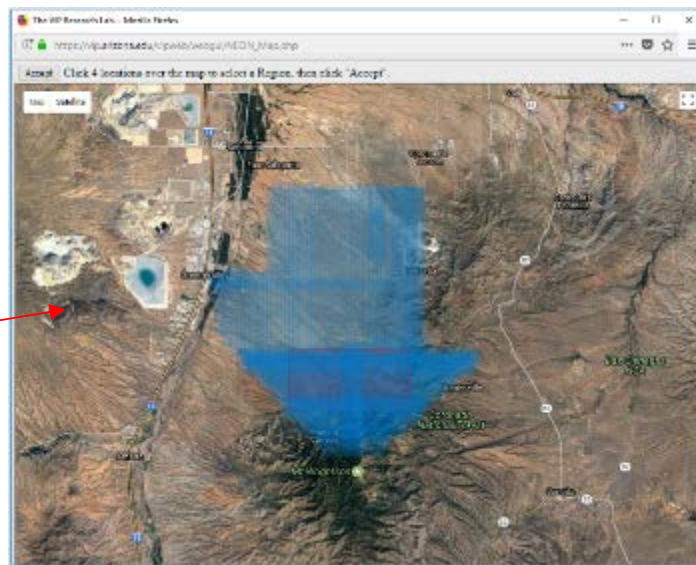
Go Close

- HDF4
- HDF5
- Geotiff
- BSQ
- ESRI Grid

- Custom
- LANDSAT7/ETM
- LANDSAT8/OLI
- MODIS
- VIIRS
- SENTINEL 2A
- SENTINEL 2B
- PROBA-V

Spectral Convolution

Spectral + spatial



Convolution is processing intensive. For now only small windows using online application.

Output contain sensor bands + NDVI/EVI2/EVI



NDVI MODIS simulated

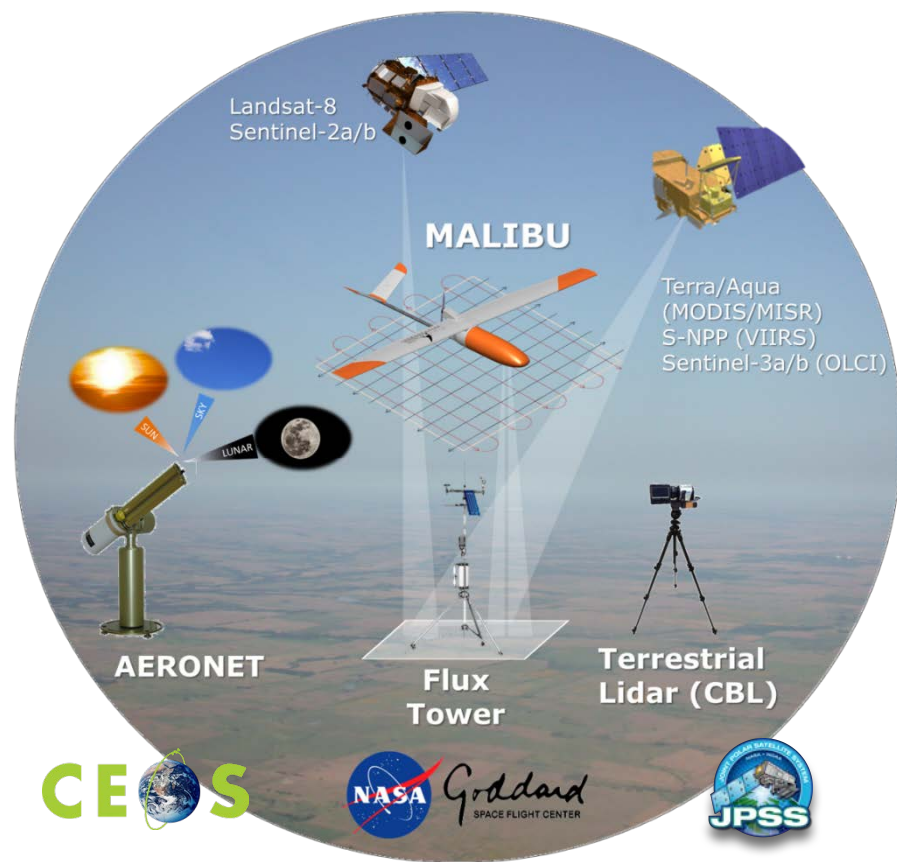


NDVI Landsat8 simulated



NDVI VIIRS simulated

# MALIBU Multi AngLe Imaging Brdf Unmanned aerial system



## Summary:

Joint GSFC 618/619 effort to develop multi-angular reference datasets for the assessment of BOA reflectance-based products (e.g., BRDF, albedo, NBAR, VI, PRI, LAI/FPAR, snow cover, and phenology metrics).



MALIBU Superswift Deployment at Table Mountain, CO

## Benefits:

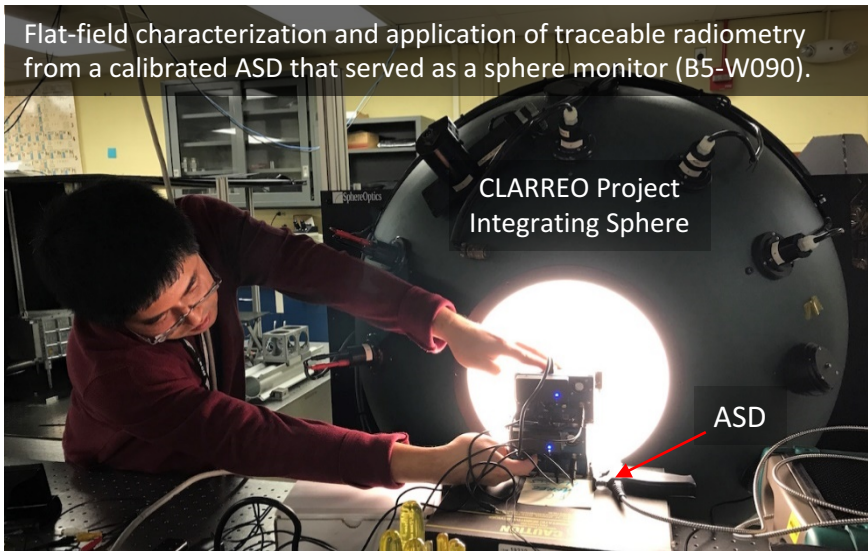
A cost effective (\$300 × Flight Hour), exempted (FAA-S.333 & TCAN) platform, that follows CEOS-WGCV good practice protocols.



# MALIBU's 'abilities' (Key Performance Characteristics)

## Traceability

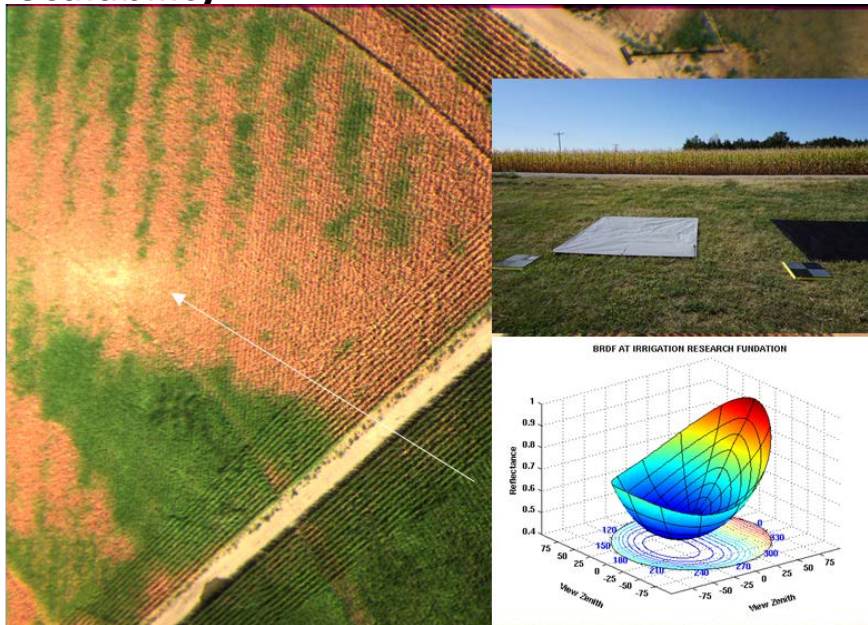
Flat-field characterization and application of traceable radiometry from a calibrated ASD that served as a sphere monitor (B5-W090).



## Mobility



## Scalability



## Adaptability

